Our Docket No.: 51876P384
Express Mail No.: EV339918300US

UTILITY APPLICATION FOR UNITED STATES PATENT

FOR

BROADBAND SLOT ANTENNA AND SLOT ARRAY ANTENNA USING THE SAME

Inventor(s):
Jong Moon LEE
Yong Heui CHO
Jae Ick CHOI
Cheol Sig PYO
Jong-Suk CHAE

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
12400 Wilshire Boulevard, Seventh Floor
Los Angeles, California 90025
Telephone: (310) 207-3800

BROADBAND SLOT ANTENNA AND SLOT ARRAY ANTENNA USING THE SAME

Field of the Invention

The present invention relates to a broadband slot antenna and a slot array antenna using the broadband slot antennas; and, more particularly, to a broadband slot antenna in which a radiating plane is electromagnetically coupled to a feedline and a slot array antenna using the broadband slot antennas.

Description of Related Art

An electromagnetically coupled patch array antenna having slots is broadly used because it is easy to attach another circuit to a microstrip feedline and feeding loss is reduced by separating a feedline and an antenna and decreasing permittivity of a board used for a feedline circuit. Although the electromagnetically coupled patch array antenna having slots has broad bandwidth characteristics, antenna gain is low and a ground plane cannot be used as a radiating plane in implementing an active device antenna.

Figs. 1A and 1B are a cross-sectional view and a prospective view of a conventional electromagnetically coupled patch antenna having a slot.

Referring to Figs. 1A and 1B, a ground plane 13 is formed on a lower dielectric board 15 such as a printed circuit board (PCB) and a feedline 16 is placed under the dielectric board

15. A radiating patch 11 is formed on an upper dielectric board such as a PCB and a conductor placed under the upper dielectric board 12 is completely removed.

Therefore, the electromagnetically coupled patch antenna having a slot provides a broadband axial ratio and broadband impedance bandwidth characteristics by stacking a plurality of the upper dielectric boards 12 on which the radiating patch is formed. However, manufacturing cost is increased and antenna gain is low.

Summary of the Invention

It is, therefore, a primary object of the present invention to provide a slot antenna using linear-polarized microstrip feeding and a broadband slot antenna enhancing electromagnetic coupling efficiency.

It is another object of the present invention to provide a slot array antenna by arranging broadband slot antennas and a broadband slot antenna using a baffle layer in order to reduce coupling of each slot antenna and enhance antenna gain.

In accordance with one aspect of the present invention, there is provided a broadband slot antenna including: a dielectric layer under which a microstrip feedline is formed; a ground formed on the dielectric layer for electromagnetically coupling the microstrip antenna through a slot; and a reflection plane placed under the microstrip feedline in order to prevent board surface waves from being

radiated and enhance antenna gain.

In accordance with another aspect of the present invention, there is provided a slot array antenna, having broadband slot antennas, each including: a dielectric layer under which a microstrip feedline is formed; a ground formed on the dielectric layer for electromagnetically coupling the microstrip antenna through a slot; and a reflection plane placed under the microstrip feedline in order to prevent board surface waves from being radiated and enhance antenna gain,

wherein a baffle layer is formed on the ground conductor in order to prevent mutual coupling and enhance antenna gain.

Brief Description of the Drawings

The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

Figs. 1A and 1B are a cross-sectional view and a prospective view of a conventional electromagnetically coupled patch antenna having a slot;

Figs. 2A and 2B are a cross-sectional view and a prospective view of a single slot antenna having high efficiency in accordance with the present invention;

Figs. 2C and 2D are a cross-sectional view and a prospective view of a slot included in a ground conductor in accordance with the present invention;

Figs. 3A and 3B are a cross-sectional view and a perspective view showing a 2 X 2 array antenna formed by arranging the broadband single slot antennas in accordance with the present invention;

Fig. 4 is a top view showing a 2 X 2 array antenna formed by arranging the broadband single slot antennas in accordance with the present invention;

Fig. 5 is a graph showing return loss of the wide slot array antenna having high efficiency in accordance with the present invention; and

Figs. 6A and 6B are graphs showing radiating patterns of the wide slot array antenna having high efficiency in accordance with the present invention.

Detailed Description of the Invention

Figs. 2A and 2B are a cross-sectional view and a prospective view of a single slot antenna having high efficiency in accordance with the present invention.

Referring to Figs. 2A and 2B, the single slot antenna having high efficiency includes a ground conductor 21, a dielectric layer 23, a microstrip feedline 24 and a reflection plane 25.

The micristrip feedline 24 is formed under the dielectric layer 23. The ground conductor 21 is placed on the dielectric layer 23 and electromagnetically coupled to the microstrip feedline 24 through a slot. The reflection plane 25 is

located under the microstrip feedline 24 and prevents board surface waves from being radiated. An open part having predetermined length and depth is located between the microstrip feedline 24 and the reflection plane 25 because the microstrip feedline 24 and the reflection plane 25 must not contact each other.

It is preferred that the dielectric layer 23 under which the micristrip feedline 24, the ground conductor 21 having the slot 22 and the reflection plane 25 are exactly aligned with each other in order to obtain enhanced coupling efficiency and the ground conductor 21 is made of red brass in order to easily coat gold on the surface of the ground conductor 21.

Also, the reflection plane 25 is a metal resonator for increasing antenna gain and preventing the board surface waves from being radiated.

A gold-coated ground conductor 21 having a slot 22 is formed on the dielectric layer 23 with reference to Figs. 2C and 2D.

Referring to Fig. 2C, areas of an entrance and a bottom of the slot are the same and referring to Fig. 2D, an area of an entrance of the slot is larger than that of a bottom of the slot.

Therefore, a linear-polarized wave having advanced coupling efficiency is obtained by exactly aligning the reflection plane 25, the dielectric layer 23 and the ground conductor 21 having single slot. Also, if multi-resonance occurs, broadband antenna characteristics are obtained. A

resonance frequency is controlled by varying a height of the reflection plane 25 and a length of a tip part of feedline 24.

A 2 X 2 array antenna is formed by arranging the broadband slot antennas of the present invention.

Figs. 3A and 3B are a cross-sectional view and a perspective view showing a 2 X 2 array antenna formed by arranging the broadband slot antennas in accordance with the present invention.

Fig. 4 is a top view showing a 2 X 2 array antenna formed by arranging the broadband single slot antenna in accordance with the present invention.

Referring to Figs. 3A and 3B, the broadband slot array antenna includes a microstrip feedline 34, a dielectric layer 33, a ground conductor 31, a reflection layer 35 and a baffle layer 36.

The dielectric layer 33 separates the ground conductor 31 and the microstrip feedline 34 and the ground conductor 31 is electromagnetically coupled with the microstrip feedline 34 through a slot 32. Also, the reflection plane 35 prevents board surface wave from radiating and the baffle layer 36 prevents mutual coupling of the slot antennas in order to increase antenna gain. The baffle layer 36 is a square shape.

As mentioned with Figs. 2A and 2B, the baffle layer 36, the reflection plane 35, the dielectric layer 33 and the ground plane 31 is exactly aligned in order to obtain enhanced coupling efficiency. The linear-polarized wave having enhanced coupling efficiency has the same structure shown in

Figs. 3A and 3B.

Referring to Fig. 3B, the 2X2 array antenna is composed of single slot antennas. A distance between slots becomes less than 1λ in order to decrease a size of side lobe. The reflection plane 35 prevents backward radiation while antenna gain is increased by using a wide slot. Also, the reflection plane 35 decreases effect of board surface wave at millimeter wave band by blocking the microstrip feedline 34. The baffle layer 36, the ground conductor 31, dielectric layer 33 and the reflection plane 35 are exactly aligned as shown in Figs. 3A and 3B in order to obtain enhanced coupling efficiency.

Fig. 5 is a graph showing return loss of the wide slot array antenna having high efficiency in accordance with the present invention.

Figs. 6A and 6B are graphs showing radiating patterns on H plane and E plane of the wide slot array antenna having high efficiency in accordance with the present invention.

Referring to Figs. 5, 6A and 6B, the present invention provides better performance than the conventional art in aspects of the return loss and the radiating patterns.

In accordance with the present invention, 10dB return loss bandwidth is 30%, i.e., center frequency is 42GHz, 3dB beam width is $\pm 13^{\circ}$, and antenna gain is 15.5dB.

As mentioned above, the present invention can obtain great performance in impedance bandwidth, 3dB beam width and antenna gain by implementing a new structure of single slot

antenna using the ground conductor having the slot and the baffle layer, the dielectric layer and reflection layer.

Also, the present invention can be implemented with lower cost by using a single dielectric layer and a metal layer, and makes easy to implement an active integrated antenna.

While the present invention has been shown and described with respect to the particular embodiments, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims.